

# A new species of *Arthroleptis* (Anura: Ranidae) from the West Usambara Mountains, Tanzania

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The herpetology of the Usambara Mountains, Tanga Province, Tanzania is primarily based on the extensive collections made by Loveridge (Barbour & Loveridge, 1928). He concentrated his efforts on the more accessible eastern half of the Usambaras, especially around Amani (5°06'S: 38°37'E) at an elevation of around 923 m and appears to have been the only person who collected amphibians in the Mt. Lutindi outlier (Hindu of Moreau, 1935), the only part of East Usambaras that rises above 1219 m and has a patch of highland and cedar forest on its peak (1506 m) similar to that which, until comparatively recently, covered a vast area of West Usambaras (Moreau, 1935). Both the East and West Usambaras consist of high mountains with dramatically steep cliffs and ridges but the western peaks and plateaux are all above 1219 m, their highest ridges reach 2286 m and the rainfall is considerably less. The eastern and western divisions of the mountains are divided by the hot, dry trench-like Lwengera Valley which is nearly 914 m deep. The forests of the Highland Zone of the West Usambaras, as defined by Moreau (1935) in his excellent account of the topography, ecology and climate of these ancient mountains, remained virtually untouched by herpetologists until the last decade when collecting has been carried out by the writer and other zoologists, notably at ca 1530 m, 37.8 km NE Soni above Mombo at the Mazumbai Forest Reserve and tea plantation, 4°48'S: 38°29'E. This Forest Reserve consists of over 600 acres given to the University of Dar es Salaam by the owner of the tea plantation, Mr John Tanner. The most profitable collecting by the writer was done at 1530 m where an irrigation channel about 1.25 m wide follows the contour from a waterfall and river in forest passing through the forest to emerge in part of the plantation. The stream of approximately 140 mm depth had a slack to moderate current with a fine gravel and mud base. On its right bank it was overhung by forest trees while its left bank had a muddy track of sodden leaves plus debris backed by balsam and wild banana. The forest trees included *Ocotea usambarensis* and *Newtonia*. Average annual rainfall measured over a seven year period (1954/60), was 1041 mm. From a stone and debris in the stream and from the stream margin five *Arthroleptis* were obtained. These together with specimens found later by other collectors, at Mazumbai and additional localities in the West Usambaras between 1450 m and 2134 m, surpass in adult size all known species of *Arthroleptis*. In colour pattern and some proportions they resemble *A. affinis* Ahl, and to a much lesser extent *A. adolfifriederici* Nieden. A comparison of them with long series of *affinis* obtained mainly at the type locality, Amani in the East Usambaras, and with the type and paratype of Ruandan *adolffriederici* suggests that an undescribed species of *Arthroleptis* exists in the West Usambara Mts.

The new species is named after Mr John Tanner in recognition of the generosity and hospitality afforded the collectors and other zoologists and his keen interest in the natural history of Mazumbai.

## Abbreviations

- BM(NH) British Museum (Natural History), London  
FMNH Field Museum of Natural History, Chicago  
R Universitetets Zoologiske Museum, Copenhagen  
ZMB Zoologisches Museum der Humboldt-Universität Berlin

*Arthroleptis tanneri* sp. nov.

*Arthroleptis adolfifriederici*: Barbour & Loveridge 1928 (part)

**HOLOTYPE.** Adult female BM(NH) 1974.59, collected by A. G. C. Grandison and F. V. Slade at Mazumbai 4°48'S 38°29'E West Usambara Mountains, Tanzania, ca. 1530 m elevation, 1000 hrs, 8 October, 1973.

**PARATYPES.** Same locality data as for holotype: BM(NH) 1974.60 (stained and cleared preparation), BM(NH) 1974.61–63, 2245–2300 hrs., 8th October, 1973, BM(NH) 1974.200 16.30 hrs. 11th October 1973, BM(NH) 1982.525–36, R 7731–35, R 7736–68, R 7797–98. Phillipshof 4°45'S 38°18'E (4 mls N of Lushoto), W. Usambara Mts: MCZ 13166. Shume-Magamba Forest Reserve, 4°40'S 38°15'E, W. Usambara Mts, 2134 m elevation, 11–16 February 1981: BM(NH) 1982.537–40. Balangai Reserve, 4°56'S 38°37'E, W. Usambara Mts, 1450 m elevation, May 1981: BM(NH) 1982.541.

**DIAGNOSIS.** A large *Arthroleptis* related to *A. adolfifriederici*, separable from that species and all other species of the genus by exceptional size (males 33.7±3.3: females 50.7 mm±4.9) and stout build. Further distinguished from the Usambara *A. affinis* by its shorter tibia, more widely set nares, slimmer, less pointed terminal phalanges, absence of supernumerary tubercles under the metatarsals, chin spinules but no denticulations along the second and third fingers in the adult male and by minor differences in the temporal colour pattern.

**DESCRIPTION OF HOLOTYPE.** Gravid female 54.0 mm SVL. Head slightly broader than long, its width 44% SVL. Length of snout from anterior border of eye to snout tip 35% of head width. Distance between the nares 11% of SVL. Canthus rostralis sharp, loreal region oblique, lips moderately flared. Interorbital region wider than upper eyelid, subequal to internarial distance. Tympanum clearly visible, the diameter of the tympanic annulus slightly greater than half the internarial distance. Snout rounded in dorsal view. Body stout. Terminal phalanges of fingers bluntly rounded, not or barely wider than distal joint, without circummarginal grooves. Toes long and slender, their terminal phalanges bluntly rounded with circummarginal grooves, the maximum width of the terminal phalanx of the 3rd toe about half the tympanic diameter and only 1/3 wider than the midpoint of the penultimate phalanx. No outer metatarsal tubercle or tarsal fold. Inner metatarsal tubercle broadly oval, its length 1/2 the distance from the tip of the 1st toe to the distal margin of the tubercle. Tibial length less than length of foot (measured from tip of 4th toe to proximal margin of inner metatarsal tubercle) 49% of SVL. No supernumerary tubercles proximal to basal subarticular tubercles of the toes. No toe web. Skin on the head and back smooth with a slight ridge extending along the canthus and lateral edge of the upper eyelid to form a curved dorsolateral line on the back.

**COLOUR IN ALCOHOL.** Dorsum mid brown with a darker rather obscure cruciform area extending from the interorbital area at the level of the middle of the eyelids to the middle of the shoulders, and bordered posteriorly by a broad pale chevron-shaped zone that is of the same intensity of brown as the top of the snout and upper eyelids. Behind the somewhat indistinct chevron is a darker area that reaches to the vent. The tip of the snout has a short light vertical streak. The lores are darker than the top of the snout and a prominent dark brown band passes from the posterior corner of the upper eyelid through the upper third of the tympanum and curves round the posterior rim of the tympanum ending at a point above the arm insertion. The under surfaces of the tarsus and metatarsus are dark brown, except for their outer edges which have a pale line from the heel along the external margin of the 5th toe to its tip. The legs and forelimbs are cross banded dark and lighter brown. The back of the thighs are mottled with pale grey. The middle of the belly is immaculate dirty white, the gular skin and chest pale fawn with creamy white mottling. The lower lip is medium brown, spotted or barred with white. Undersurfaces of the hind limbs dirty white with a faint greyish network. Undersurfaces of toes rather pale, the subarticular and metatarsal tubercles cream. Undersurfaces of hand uniform dirty cream.

**HABITAT.** The holotype and some of the British Museum paratypes were associated with *Rana angolensis* Bocage and *Phrynobatrachus kreffii* Boulenger. One adult female was on a stone jutting out of the stream, others in holes in rotten logs or under logs or on leaf litter, while the holotype and two other paratypes were among floating plant debris and twigs at the stream margin. The Copenhagen paratypes were reported as being on the forest floor about 1.6 km from water near to where the forest is replaced by heather on Mt. Sagara above Mazumbai.

**COLOUR IN LIFE.** The general dorsal colouration of the British Museum series was claret-brown with the chain of vertebral markings from the interorbital region to the lumbar region of a darker shade. The hands and feet were pinkish, especially their undersurfaces. Upper half of iris was pale gold.

**VARIATION IN THE PARATYPES.** There is a limited amount of variation in the distinctness of the dorsal pattern, the dark area over the occiput and the pale chevron immediately posterior to it being more clearly defined in younger individuals. Furthermore in the long series of smaller specimens (R 7736-68) some tend to have dark specks at the posterior margin of the chevron and small dark brown spots on flanks and temporal region. The cruciform area is replaced in some of the paratypes by a dark inverted triangular zone from the posterior limit of which two dark oblique bands extend towards the flanks. The undersurface of the head varies from grey mottled white to an almost uniform brown which in a sexually mature adult male has an even darker band laterally. The dorsal skin of the juvenile BM(NH) 1974.200 has small scattered warts.

**SECONDARY SEXUAL CHARACTERS.** As already indicated in the species diagnosis, male *tanneri* are smaller than females. Only four males are available and all have unpigmented testes. The smallest R7735 (30.0 mm SVL), is the only one that has spinules on the chin, and a dark brown almost black area along the lower jaw medial to the barred lip. No other secondary sexual differences are apparent. All the gravid females have large unpigmented eggs with a maximum diameter of 3.5 mm.

**COMPARISON.** Although *A. tanneri* attains a larger size than *A. affinis* Ahl, the taxon described from Amani, East Usambaras and reinstated by Skelton-Bougeois (1961), there is a strong superficial resemblance. However, statistically significant differences at the level  $P < 0.001$  using two sample t-test exist in the following percentage ratios of samples of the two species.

	<i>A. tanneri</i>		<i>A. affinis</i>	
	gravid ♀♀	♂♂♀♀, subadults	gravid ♀♀	♂♂♀♀, subadults
<i>Head width</i>	n 6	n 19	n 10	n 32
<i>SVL</i>	$\bar{x}$ 44.17	$\bar{x}$ 43.34	$\bar{x}$ 42.0	$\bar{x}$ 42.01
	S 1.17	S 1.86	S 1.56	S 1.29
<i>Head width</i>	n 6	n 19	n 11	n 32
<i>Tibia length</i>	$\bar{x}$ 88.5	$\bar{x}$ 84.31	$\bar{x}$ 77.2	$\bar{x}$ 75.36
	S 5.0	S 6.09	S 2.40	S 3.38
<i>Tibia</i>	n 6	n 19	n 13	n 32
<i>SVL</i>	$\bar{x}$ 49.8	$\bar{x}$ 51.83	$\bar{x}$ 54.8	$\bar{x}$ 55.78
	S 3.06	S 3.36	S 3.10	S 2.60
<i>Internarial distance</i>	n 6		n 11	
<i>SVL</i>	$\bar{x}$ 11.15		$\bar{x}$ 12.62	
	S 0.52		S 0.51	



No statistically significant differences in the percentage ratios of the internarial distance to SVL were found in samples of *tanneri* and *affinis* that included halfgrown individuals as well as adults of both sexes. Breeding males of *tanneri* and *affinis* may be distinguished by their different secondary sexual characters. None of the sexually mature male *affinis* has chin spinules but all have a row of denticulations along the inner border of the 2nd and 3rd fingers and the 3rd finger is elongated. Of the two males obtained by Loveridge at Phillipshof West Usambaras and identified by Barbour & Loveridge (1928) at *adolffriederici* Nieden, the larger individual (37.4 mm SVL) MCZ 13166 has neither chin spinules nor denticulated fingers but agrees in proportions and in other characteristics with *tanneri* while the smaller specimen (29.1 mm SVL) MCZ 13167 is a typical *affinis* and has finger denticulations. Like all the males and females of *affinis* from the East Usambaras, both those from the Highland Zone (Mt. Lutindi) and from the Intermediate Forest of Amani, the Phillipshof example MCZ 13167 bears a prominent supernumerary tubercle under the distal portion of the 2nd and 3rd metatarsals and additional but smaller tubercles scattered over the sole of the foot. In some individuals of *affinis* a small tubercle is also present at the base of the first toe between the inner metatarsal tubercle and the subarticular tubercle (Fig. 2). Ahl (1939) in his type descriptions of *affinis* and of the junior synonym *A. schoenbecki*, both of which were obtained at Amani, mentions the supernumerary tubercles which bedeck the soles of the feet in the type specimens but makes no reference to the more distal tubercles under the 2nd and 3rd metatarsals. Examination of the type material in the present study has confirmed their presence.

Supernumerary tubercles under the metatarsals are absent from every individual of *tanneri*, as well as from the holotype and paratype of *A. adolffriederici* from Rugege and Bugoya Forests Ruanda (Fig. 2). A third example also collected at Rugege and referred to *adolffriederici* by Nieden (1912) also lacks these tubercles. However *adolffriederici* differs from *A. tanneri* in its smaller size, the adult female holotype and paratype being 41.1 mm

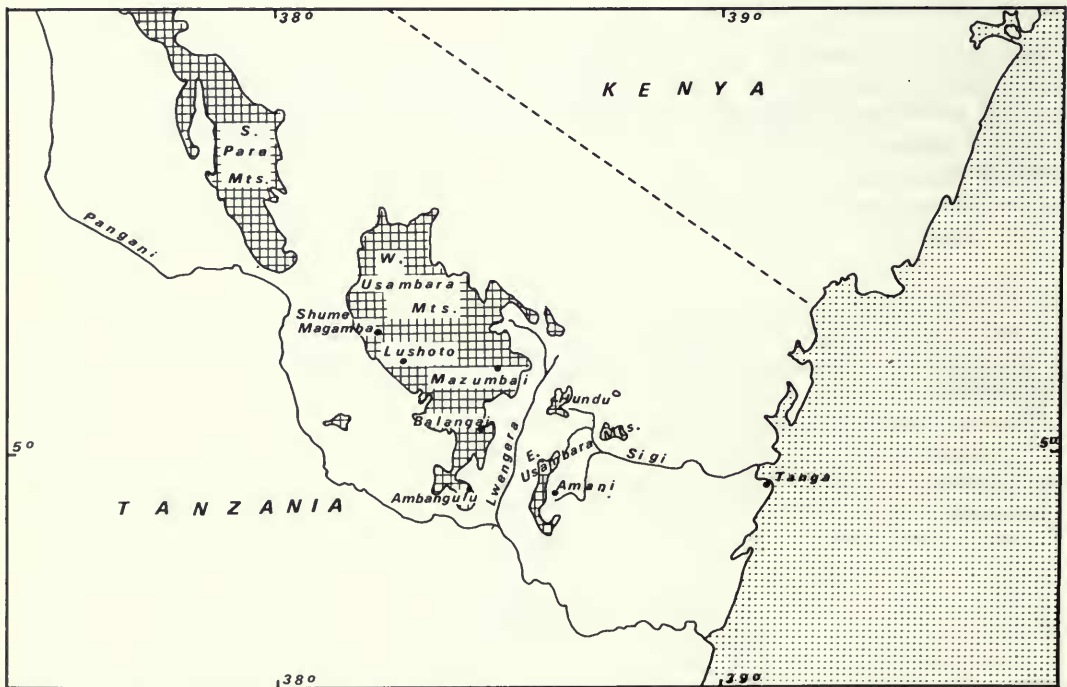


Fig. 1 The Usambara Mountains, NE Tanzania. Land over 1000 m is indicated by cross hatching.

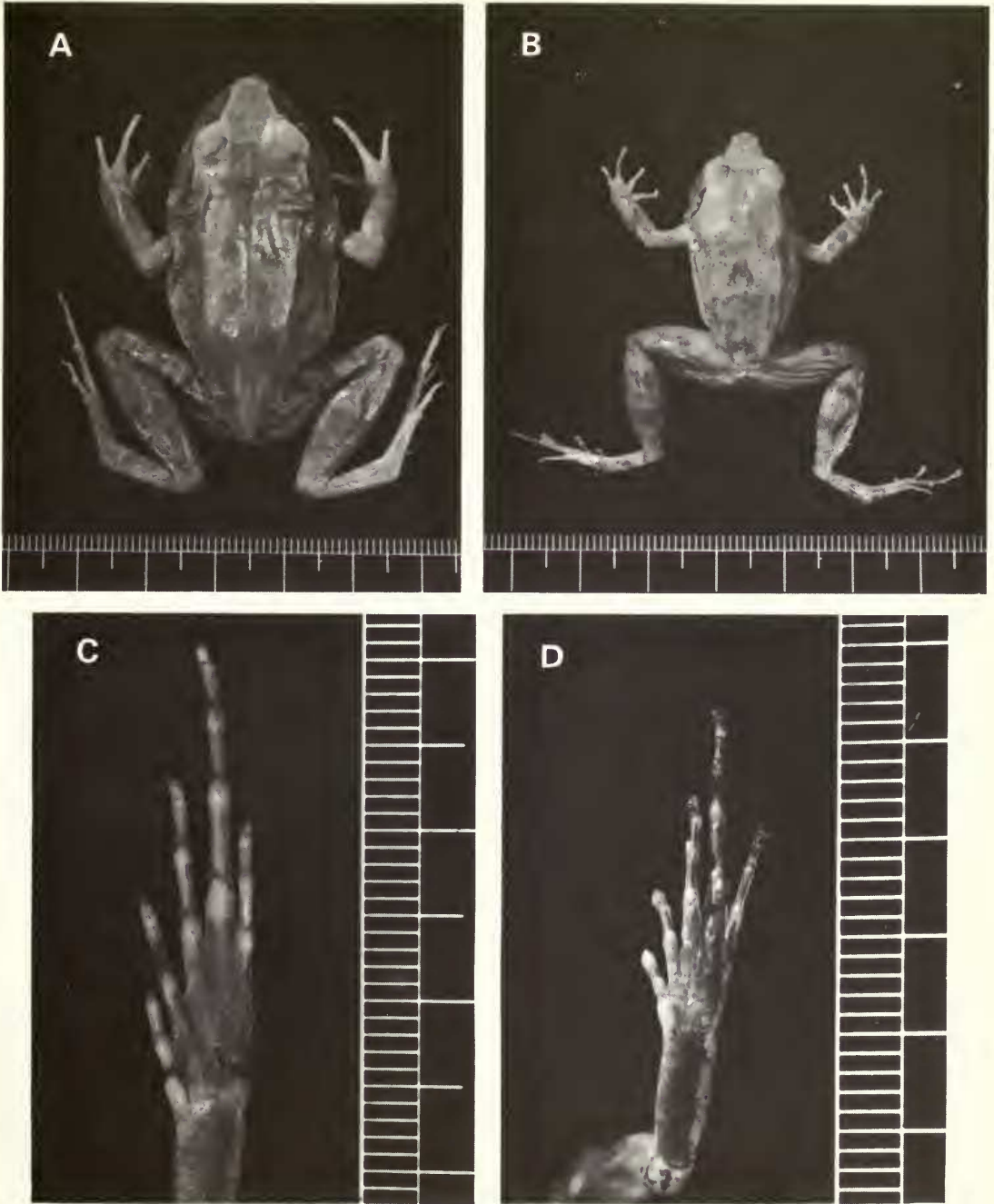


Fig. 2 Dorsal view and undersurface of the foot of: *Arthroleptis tanneri* sp. nov. (A & C); *Arthroleptis affinis* (B & D).

and 43.8 mm SVL, as well as in its marbled dorsal pattern (Nieden, 1912) and further differs from both *tanneri* and *affinis* in its much narrower head and shorter internarial distance and tibia. Percentage ratios in the holotype and paratype of *adolfriederici* of head width/SVL are 35.0 and 33.1, of internarial distance/SVL 10.70 and 10.27, of head width/tibia length 61.0 and 55.34. *A. tanneri* seems to be further distinguished from either

*adolffriederici* or *affinis* by its terminal phalanges being bluntly rounded and barely wider than the distal joint. In the Ruanda *adolffriederici* and in the East Usambara series of *affinis* they tend to be sharply pointed and are decidedly wider than the proximal phalanges and joints.

In colour pattern *tanneri* and *affinis* are rather similar but whereas in *tanneri* the ventral surfaces of the toes are cream, in *affinis* the phalanges and the soles of the feet are dark brown and the cream subarticular tubercles are in sharp contrast. Also in *affinis* the supratympanic stripe generally curves round the top of the tympanic annulus and does not pass across the tympanic membrane.

### Osteology

The stained and cleared adult female paratype of *tanneri* was compared with a similarly prepared Amani adult of *affinis*. Osteological differences that are interpreted as being of taxonomic significance are limited to the skull, in particular the shape, extent of the sphenethmoid including the degree of its dorsal exposure, the medial separation of the nasals and the shape of the anterior borders of the frontoparietals.

In *tanneri* the sphenethmoid is a short squat bone, sharply concave posteriorly and with a straight anterior border that fails to reach the palatines except for their medial posterior tips. It has no dorsal exposure, being completely covered by the frontoparietals. The sphenethmoid in *affinis* not only projects much farther forward to extend well beyond the palatines and to the level of the anterior edges of the choanae, but its anterior and posterior borders are of a different shape from those of *tanneri*, being deeply convex and straight respectively. Furthermore the sphenethmoid has a crescentic dorsal exposure.

In both taxa the palatines are robust and contact the maxillae broadly but fail to reach the pterygoids.

Not only are the medial borders of the nasals more convex and wider apart in *affinis* but there is a greater separation between the nasals and the frontoparietals; moreover the anterior borders of the frontoparietals project forwards instead of as in *tanneri* being straight.

It is considered unlikely that these differences are attributable to individual variation in view of the author having discovered in an extensive analysis of bufonid skulls that there is virtually no intraspecific variation in adults in the shape and size of the sphenethmoid, palatines, nasals and frontoparietals.

### Distribution of *A. tanneri* and its relationship with *A. affinis*

In the eastern half of the Usambara Mts *A. affinis* is known from Amani, 923 m, and from 1219 m on Mt. Lutindi (Hundu). In the neighbourhood of Amani during the dry season the writer found *affinis* to be abundant among leaf litter, in cracks in the impacted earth of road cuttings and in mounds of earth, sometimes in association with *Callulina kreffii* Nieden and *Nectophrynoides tornieri* Roux. Loveridge obtained 192 examples from leaf strewn paths at Amani (Barbour & Loveridge, 1928). At comparable elevations in the western half of the Usambaras no herpetological fieldwork has been undertaken below 1219 m and only one *Arthroleptis* has been taken at 1219 m, on the Ambangulu Estate, Korogwe District, 5°05'S, 38°26'E. The single individual, a juvenile of 20.0 mm displays features of both *tanneri* and *affinis*. It resembles *affinis* in having supernumerary tubercles under its metatarsals but its proportions correspond more closely to those of *tanneri*, its percentage ratios being Head width/SVL 45.0, Head width/Tibia 90.0 and Tibia/SVL 50.0. The existence of this aberrant individual raises the question of whether *tanneri* and *affinis* coexist at Ambangulu and whether the 'mixed' characters of this juvenile can be attributed to hybridisation. Further material from this and other localities at lower elevations in the West Usambara Mts is awaited with interest.

Evidence of sympatry of *A. tanneri* and *A. affinis* rests on the two adult males collected by



Loveridge in 1926 during ten days spent at Phillipshof in the West Usambaras. Barbour & Loveridge (1928) quote the elevation of Phillipshof as approximately 5500 ft (1676 m), which accords with information given to the author by the Royal Geographical Society based on the 1916 War Office maps of Tanganyika Territory and the Lushoto sheet 1 : 250 000 which place Phillipshof four miles north of Lushoto, 4°45' S 38°18' E, elevation 1524–1829 m. Barbour & Loveridge (1928) describe Phillipshof as 'rolling downs of grazing land, marshy swamps and slow-flowing streams in the bottoms, scattered patches of rain-forest on the uplands, with vast stretches of forest nearby on either side of the Malindi road'. According to Moreau's (1935) zonation of the Usambaras Phillipshof lies in the same Highland Zone as Mazumbai. It is not known whether the Phillipshof examples of *tanneri* and *affinis* were found in similar niches and closely associated with each other or whether they occupied quite different biotopes; no precise field data accompany the specimens. Except for the Phillipshof record of sympatry and the unique characters of the Ambangulu juvenile the available material points to *tanneri* and *affinis* being separated geographically and by altitude with *A. tanneri* confined to the West Usambara Mts in the Highland forest zone of Moreau (1935) and *A. affinis* occurring at the lower elevations of the Intermediate forest zone of the East Usambara Mts.

### Additional material used in study

#### *Arthroleptis adolfifriederici* Nieden

Bugoya Forest, Ruanda: ZMB 21787 (Paratype).

Rugege Forest, Ruanda: ZMB 25287, FMNH 73836 (ZMB 21789) (Holotype).

#### *Arthroleptis affinis* Ahl

Amani 5°06' S 38°37' E, E. Usambara Mts, Tanzania 923 m: BM(NH) 1974.177 (stained and cleared preparation), BM(NH) 1974.170–176, BM(NH) 1974.178–185, BM(NH) 1974.186–195, MCZ 88131–278, MCZ 13153–60, FMNH 73836, ZMB 25289 (holotype of *A. schoenebecki* Ahl), ZMB 23093 (holotype of *A. affinis*), R 7797–98, R 77100.

Mt. Lutindi, E. Usambara Mts, Tanzania: MCZ 13161–65.

Phillipshof, W. Usambara Mts, Tanzania: MCZ 13167.

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